THE VASCULAR ANATOMY OF THE FOUR-ROWED EAR OF CORN

R. A. LAUBENGAYER
Wabash College, Crawfordsville, Ind.

The question of row number eventually arises in any complete study of the ear of corn. It is likely to become involved especially when the origin of the ear is considered. Several years ago the late Dr. R. A. Emerson was growing certain strains of corn in a study of row inheritance. He obtained several ears with four rows from some of the crosses and these were made available to the writer for anatomical study. The immediate ancestry of the plants which produced these ears is not known.

METHODS AND MATERIALS

The same general methods were employed for the examination of the internal anatomy of these 4-rowed ears as were used for the 8-rowed ear.[1] The ears were studied when mature in size but sufficiently soft so that, without embedding and further treatment, serial sections of 160 μ could be made. No staining was necessary to distinguish the vascular bundles when sections were mounted in glycerin. In addition to cross-sections, retted material was used to aid in getting a three-dimensional picture.

The ears examined conformed in external appearance to descriptions which have already been given for this type of ear. The spikelets were arranged in two pairs of rows opposite each other (pl. 36, fig. 1), thus giving a rectangular appearance in cross-section. Between the pairs of rows were smooth faces. Had these been 8-rowed ears, pairs of rows would have formed on these faces. The specimens showed occasional extra kernels indicating the development of the second flowers of some spikelets.

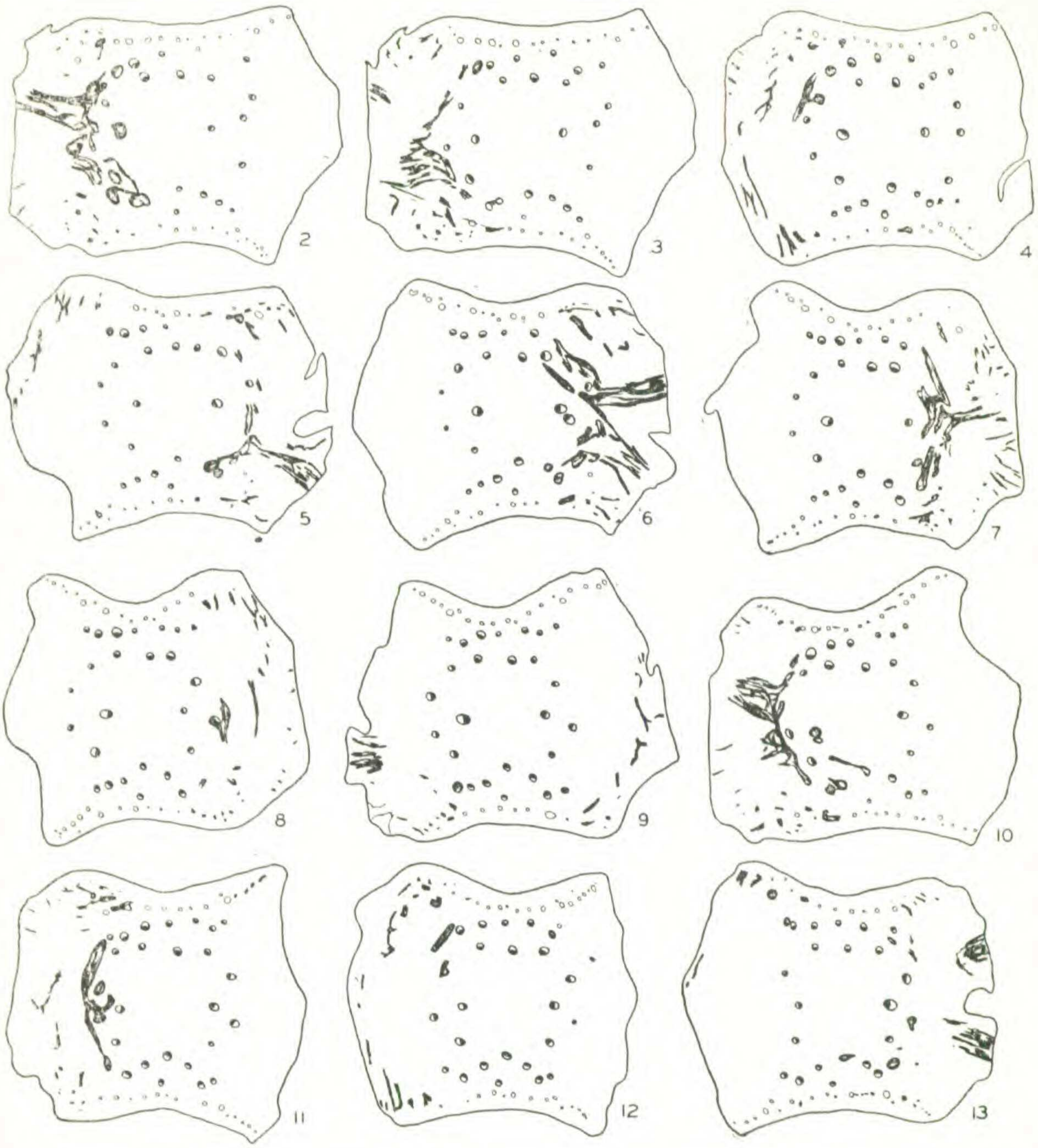
The general pattern of description used is that previously employed for the 8-rowed ear to which frequent reference will be made. In order to distinguish the vascular bundles of the inner and outer systems in the diagrams more readily, those of the inner system have been partially blocked in.

DESCRIPTION

The change in number, the size, and the arrangement of the bundles in the transition region from the shank to the ear could not be made since the specimens had been collected without the shanks. All indications were that it was essentially like that of the 8-rowed ear previously discussed. The diagrams used in the description represent a part of a series of cross-sections cut about halfway up the ear and extending about four nodes (assuming that each pair of spikelets represents a node) acropetally. The staggering of the pairs of spikelets on the opposite sides aided in interpretation.

---

[1] Laubengayer, R. A. Paper in press.



Figs. 2–13. Diagrams representing a part of series of cross-sections extending about four nodes.

There is a distinct inner system of bundles—those that are partially blocked in—which contribute to the vascular supplies of the pairs of spikelets along one side (fig. 2). This supply formation is essentially as it is in the 8-rowed ear. It is evident from figs. 3 and 4 that with the passing out of the main spikelet supplies, the bundles again reorganize in their previous relative positions. At the next higher level, the bundle complex on the opposite side is forming the next higher spikelet supplies (fig. 5). This is obviously a repetition of the reorganization of the vascular system at the lower level. The inner system at the level of fig. 9 is shown in its entirety without any spikelet supplies. From the level indicated in

fig. 10 through that shown in fig. 11, the supplies to the next higher pairs are indicated. Thus, there is a very uniform sequence of vascular supply formation acropetally.

It is obvious that the bundle organization is much like that in the 8-rowed ear, as seen by the inner system at the level indicated in fig. 9. If the courses of the median bundles along the smooth faces are followed, it is seen that these are not involved in contribution to the spikelet supplies. This was found to be true in all ears studied except in a single small one. In this one, all bundles of the inner system contributed to the spikelet supplies. Bundles facing the smooth side also contribute in the formation of the spikelet supplies. Hence the system of vascular bundles contributing to the supply of the spikelets is far more extensive laterally than was evident in the 8-rowed ear.

The outer system of bundles is likewise more extensive than was observed to occur in the 8-rowed. As seen in all the figures, the bundles are arranged across the sides without spikelets, with a greater concentration at the corners which are directly associated with the supplies to the glumes (figs. 3–5 and 7–9). There is a lateral anastomosing of these same corner bundles between the levels at which the spikelet supplies leave the axis. This anastomosing gives complete continuity of the bundles of this outer system across the sides bearing spikelets.

A number of bundles of this outer system along the smooth side do not enter into the supplies to any parts. They run the entire length of the ear with little lateral fusion. Thus along the smooth face, there is at least one of the bundles of the inner system and a number of the outer system which run the length of the ear without supplying any organs.

As an aid in the interpretation of these systems, the retted material as shown in pl. 36, fig. 14 helps considerably. Not only do the vascular supplies to the glumes stand out in definite profile, but the remainder of the vascular bundles of the outer system show clearly across the smooth face. Bundles of the inner system can be seen plainly even though they lie below the outer.

DISCUSSION

The anatomical structure of the 4-rowed ear shows a striking similarity in structure with that of the 8-rowed. That there are present two distinct systems of vascular tissue cannot be emphasized too strongly. Paralleling the condition in the 8-rowed ear, the stronger inner system furnishes the main supplies to the paired spikelets. These supplies are formed over a very short distance vertically and pass out almost at right angles into the spikelet axes. In contrast to the condition present in the 8-rowed ear, the bundle complex involved in the supply to the spikelets is greater in circumference so that the total bundle supply is greater than in the 8-rowed. However, there are usually some bundles which do not enter into these supplies—those always on the sides that bear no spikelets. Only in one small ear examined were all the bundles associated with spikelet supplies.

The outer system is relatively stronger than that in the 8-rowed ear. At the margins of the faces which bear the spikelets, the smaller bundles behave in the same fashion as in the 8-rowed. They furnish the complete vascular supply to the two glumes of each spikelet, completely independent of the outer system. Between the levels at which the main supplies to the spikelets pass out, they form complete lateral connections. The presence of bundles of this system offers an unusual condition on the two sides along which there are no spikelets. These bundles show very little lateral fusion and extend the entire length of the ear. They were in no way connected with the supply to any structure in the specimens studied.

The presence, along the two smooth sides of the ear, of parts of the inner system and outer system is significant. From a physiological standpoint, there is far greater proportion of vascular tissue present than would usually be present to supply such an amount of tissue. It is generally accepted that in all groups of plants there are forms which show relatively large amounts of vascular tissue supplying comparatively small masses of tissue. This is usually interpreted as evidence of reduction; the loss of an organ or organs often is completed before the disappearance or radical modification of the vascular tissue supplying these organs. The vascular tissue represents a conservative portion of the plant body and therefore responds more slowly to change in conditions. If this is true in the case of the 4-rowed corn ears, then the present 4-rowed condition is a derived one. Hence it would not represent a primitive condition—if one uses the number of paired rows as a criterion—but a more advanced one; a simpler condition derived from a more complex one. This would be in keeping with the interpretation of similar structures found in other plants. If this is true in the 4-rowed ears, it may be that similar reductions may exist in the higher-rowed ears, with internal evidence. This might well necessitate a general change in the interpretation of the row number of the corn ear.

SUMMARY

The 4-rowed ear of corn shows a basic pattern of vascular tissue which resembles that of the 8-rowed ear. There exist pronounced inner and outer systems which probably differentiate at the base of the ear. The inner system furnishes the main vascular supply to the spikelets; the source of supply is more extensive circumferentially than in the 8-rowed ear. The outer system is associated with the supplies to the lower glumes. The presence of bundles of the inner and outer systems, which do not supply any organ, along the sides without spikelets indicates that a reduction has occurred.

Explanation of Plate

PLATE 36

Fig. 1. Side view of four-rowed ear of corn.
Fig. 14. Retted specimen of four-rowed ear.